Spray Dryer Process Air Permit

Hercules Research Center – 500 Hercules Road

Public Hearing
December 8, 2016

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Wilmington Research Center Campus

Location of Spray Dryer Process

500 Hercules Road, Wilmington, Delaware 19808

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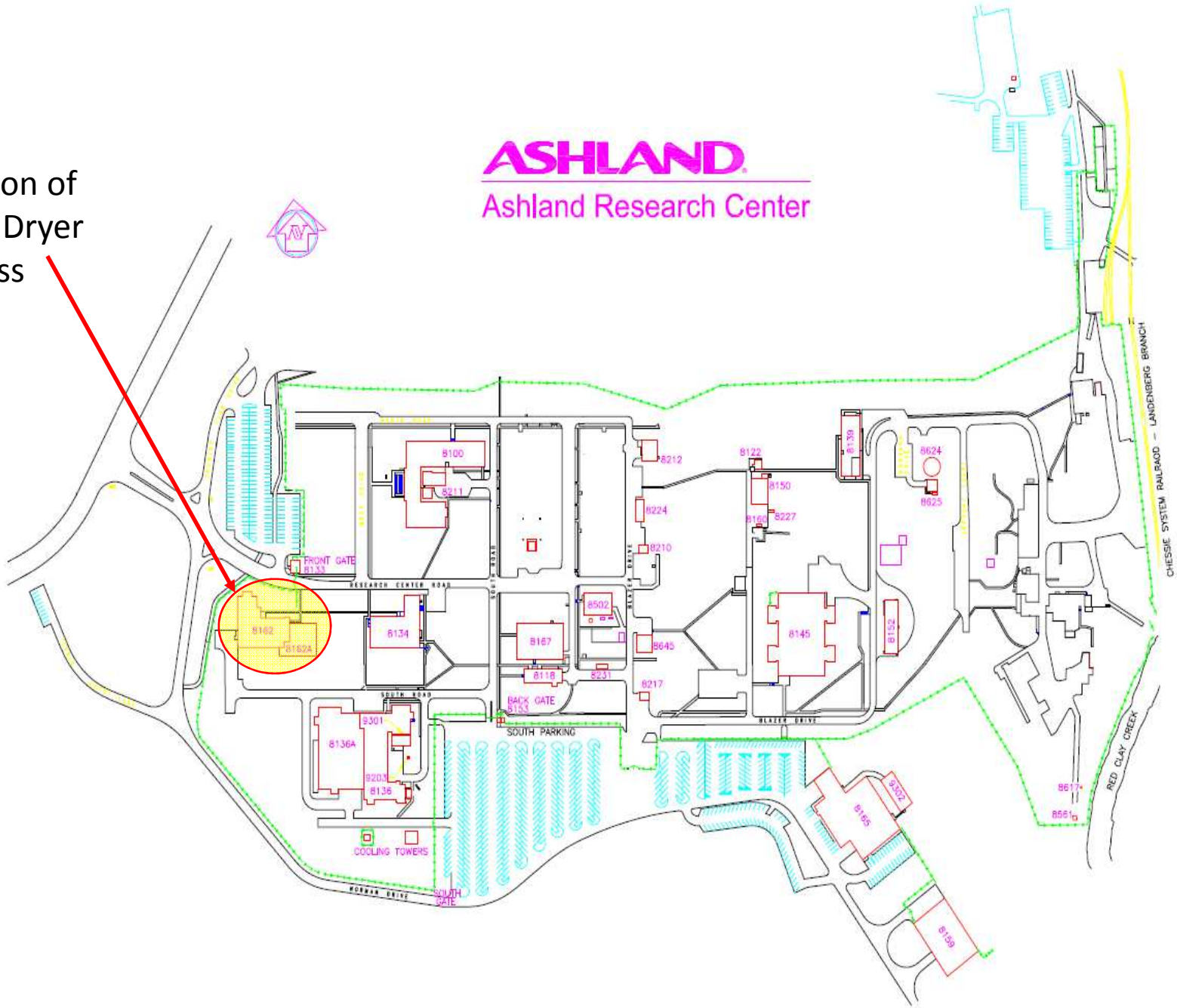
Location of Spray Dryer Process



Overview

- Seeking to permit pilot and lab scale R&D operation located in center of active 50 acre campus with 400 employees. Primarily weekday operation; limited after hours work.
- Hercules remains a subsidiary of Ashland and operates facility for Ashland
- Administrative and Research & Development (R&D) headquarters for Ashland
- Creates samples by replicating the way customers would use Ashland's products on smaller scale

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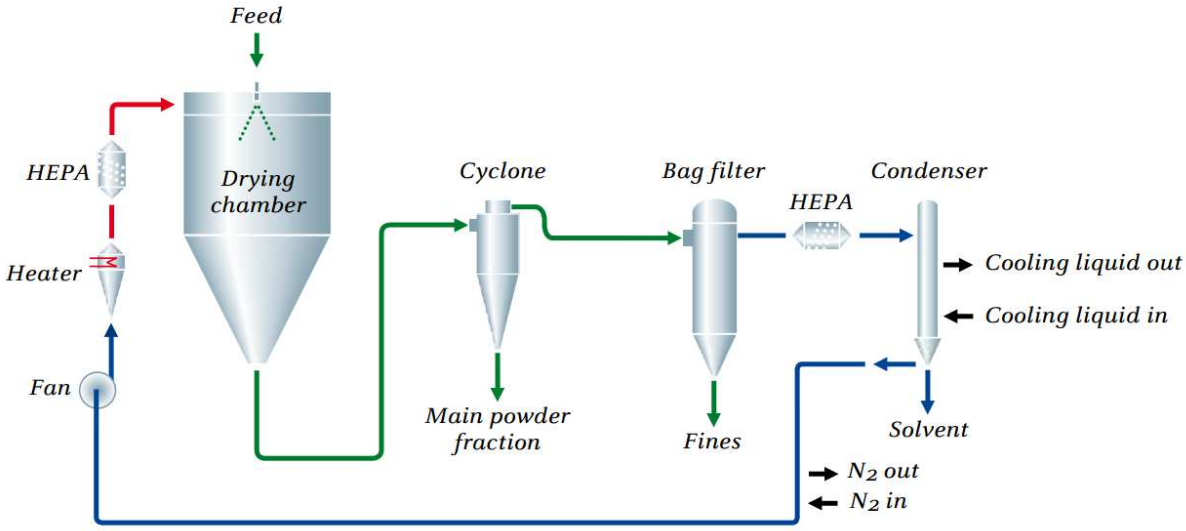
Proposed Operational Permit

- Spray dryers installed and operated pursuant to construction permits issued in April 2014
- Primary method of emissions reduction is activated carbon beds in canisters, which adsorb the pollutants

Equipment Description

- Spray Dryers (3)
  - Makes dry powder by blowing hot gas (air or nitrogen) to evaporate liquid containing active ingredient, Ashland product and solvent
  - Powder collected in cyclone; solvent vapors from dryer collected in carbon bed
  - Condensed solvent is collected and disposed of as waste
- Fluid bed dryer (1) also creates powder from liquid containing active ingredient, Ashland product and solvent
- Carbon adsorption system (1) is a two carbon canister system that adsorbs solvent vapors from dryers for emissions reduction
  - The first carbon bed has a 90% efficiency
  - The second carbon bed provides additional reduction

Pharmaceutical Spray Dryer



Closed loop configuration

Typical batch:
Run time = 4 hours
Sample size (solid) = 2 kg (4 lb)
Solvent used = 8 kg (18 lb or ~2.25 gal)

Room height = 10 feet

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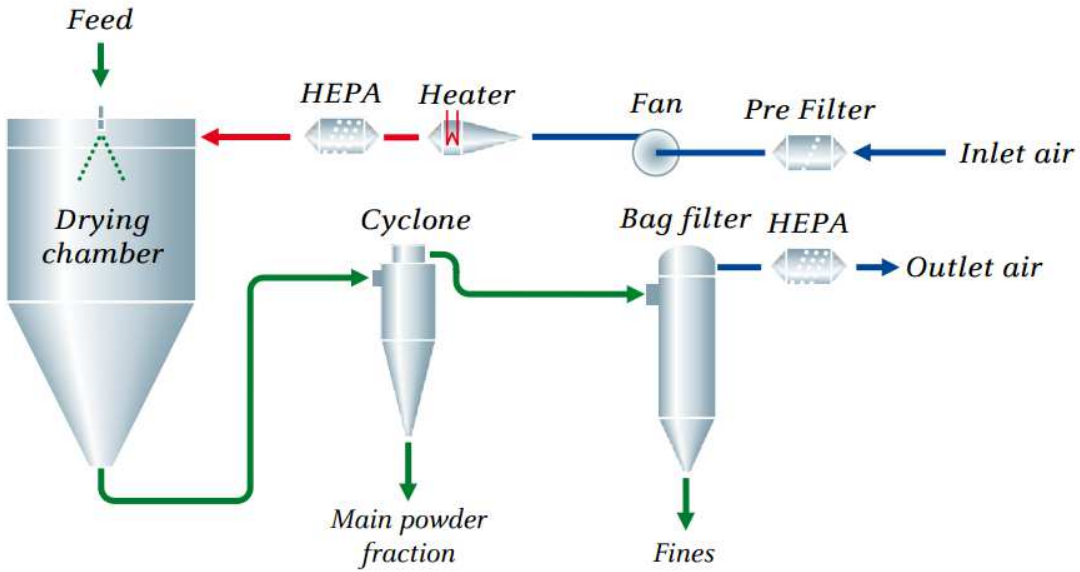
Micro Spray Dryer



Once-through configuration

Typical batch:
Run time = 0.5 hours
Sample size (solid) = 0.02 kg (0.04 lb)
Solvent used = 0.38 kg (0.8 lb or ~13 oz)

Room height = 10 feet

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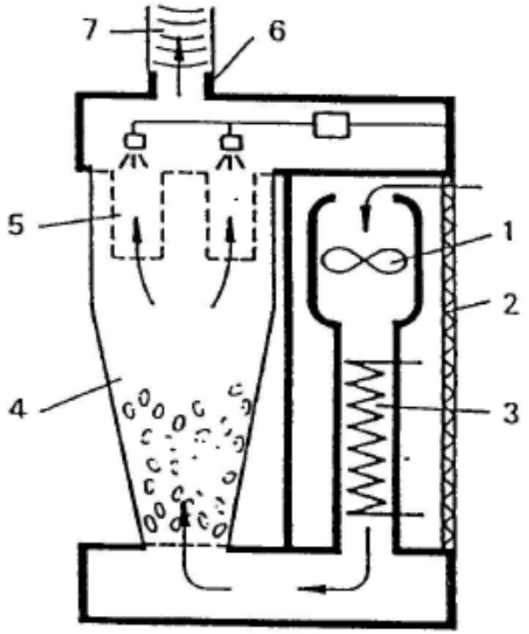
Fluid Bed Dryer



Process Flow Diagram

Room height = 10 feet

Typical batch:
Run time = 2 hours
Sample size (solid) = 0.2 kg (0.4 lb)
Solvent used = 1.8 kg (4 lb or ~0.5 gal)

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Carbon Adsorption System

Two 2,000 lb Activated Carbon Bed Canisters Operated in Series

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Potential Solvents Used

Solvent	Type
Ethanol	VOC
Isopropyl Alcohol	VOC
Ethyl Acetate	VOC
Tetrahydrofuran	VOC
Methanol	VOC-HAP
Methylene Chloride	HAP
Acetone	Non-VOC Non-HAP

Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Ethanol (Grain Alcohol)	• Beer, wine, alcohol • Clean burning fuel for portable stoves • Fuel and gasoline additive (Gasohol) • Disinfectant • Preservative for biological specimens Used in: • Varnishes and perfumes • Prep for essences and flavorings • Medicines/drugs	• Local liquor store (100 Proof = 50% Ethanol / 50% water plus some flavor; 150 Proof = 75% Ethanol / approx 25% water plus some flavor) • Any hardware store such as Home Depot, Lowes, etc. as denatured alcohol in 1 quart cans	  

Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Methylene Chloride	• Paint stripper and a degreaser • Decaffeinates coffee and tea • Prepares extracts of hops and other flavorings • Aerosol spray propellant • Blowing agent for polyurethane foams	• Any hardware store such as Home Depot, Lowes, etc. (Note: Kleen Strip Stripper is about 80% Methylene Chloride, 20% Methanol)	 

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Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Isopropanol (IPA)	• Rubbing Alcohol • Antiseptic, disinfectant • Toilet bowl and window cleaner • Swimmers Ear Widely used as: • Solvent and cleaning fluid, especially for dissolving oils	• Any drug store as either 70% or 90% IPA/water up to 99% IPA/water • Any home supply store as window cleaner	

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Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Methanol (Wood Alcohol)	• Windshield wiper fluid antifreeze • Denaturant in denatured alcohol • Clean burning fuel for portable stoves • Biodiesel fuel production	• Any hardware store such as Home Depot, Lowes, etc.	  

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Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Acetone	• Nail polish remover • Component in Superglue	• Any drug store as nail polish remover • Any hardware store such as Home Depot, Lowes, etc.	  

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Potential Solvents Used

Solvent	Common Uses	Readily Available At	
Ethyl Acetate	• Glues • Nail polish removers • Decaffeinates coffee and tea	• Any hobby store	
Tetrahydrofuran (THF)	• Industrial solvent for polyvinyl chloride (PVC) • Used in varnishes	• Any hardware store such as Home Depot, Lowes, etc. (Note: Oatey PVC Cement contains 10 - 25% THF plus some Acetone)	

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Safety

- Nitrogen used for flammable solvents
  - System kept under positive nitrogen pressure
- Interlock system
  - Temp/press/flow process parameters are monitored/interlocked
  - Won't operate unless condenser is working and system is airtight
  - Two oxygen sensors (primary and back-up) to shutdown system if air enters system
- Spill control and management
- Carbon bed redundancy
- Particle collection (baghouse and HEPA filter)

Maintenance

- Per batch cleaning
- Carbon Beds
  - Replace when solvent vapors introduced to system is 85% of carbon bed capacity
  - Change out primary bed and move secondary bed to primary
- Leak test when operating and other maintenance as necessary
- Solvent waste is collected in drums and periodically disposed offsite through Ashland approved and state licensed vendors

Monitoring

- Emission estimate
  - Track (via log) how much solvent is being used
  - Use an agency-approved material balance calculation that assumes that all solvents that are not condensed are sent to the carbon bed
- Leak test

THANK YOU

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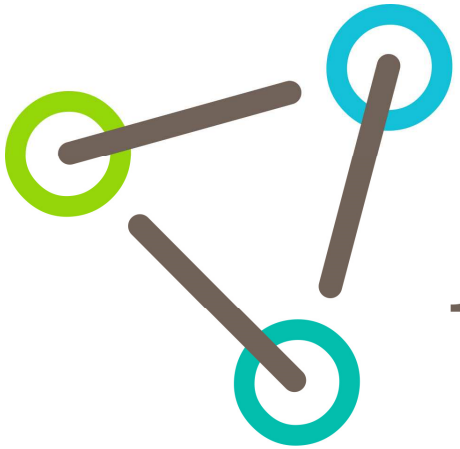

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Back-up Slides

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Wilmington Campus

Operations include:

- Primarily R&D activities
  - Molecular Science
  - Process Research
  - Measurement Science (Analytical & Materials)
  - Pharmaceutical and Nutrition
  - Industrial Specialties (includes Energy)
- Office/Administrative & Facility Services
- Aquarius – small scale Pharma production
- Solenis R&D for water technologies

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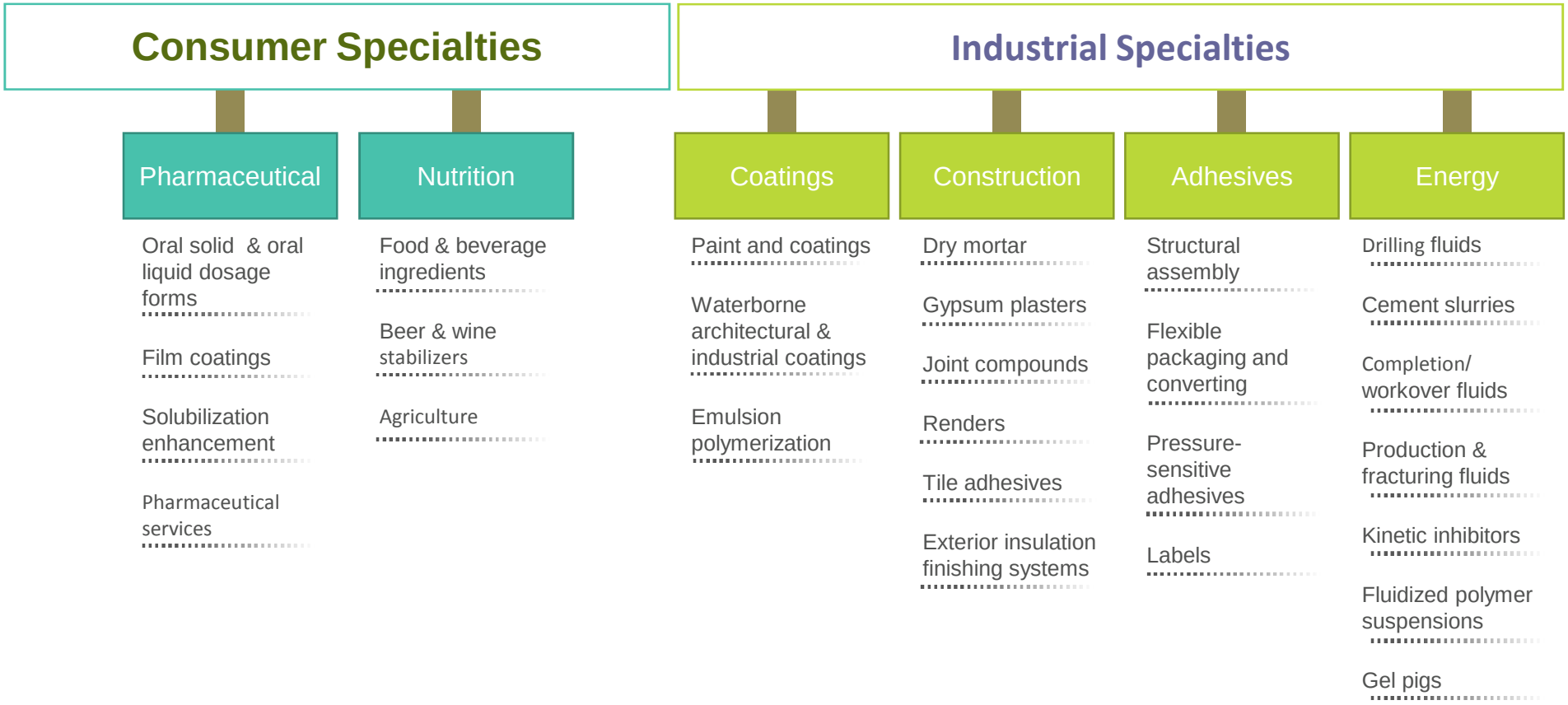
Our Markets and Applications



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